State of California
Department of Public Works
Division of Highways
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Materials and Research Department

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TESTS OF COARSE AGGREGATE
from
MURRAY CANYON PIT
of
H. G. FENTON MATERIAL COMPANY
when separated by
HEAVY MEDIA PROCESS

Three samples of rock were received during March, 1956, from Western Machinery Company representing aggregates from the Murray Canyon Pit of Fenton Material Company before and after separation by the heavy media process. One sample was described as "pit-run". One sample was "float" material which had a specific gravity less than that of the heavy media (about 2.55). The third sample was "sink" material having an average specific gravity greater than the media.

The grading of each sample as received is shown in Table I. Specific gravity (saturated, surface-dry basis), absorption and sedimentation values are given in Table II. It will be noted that differences in specific gravity are not very large. Sedimentation tests were made on separated

fractions of the samples as received. The tests were repeated on the samples after they had been subjected to the washing action of the original sedimentation test.

Detailed results of tests for sodium sulphate soundness of the pit-run and sink material are given in Table III. The soundness test was not made on the float material.

After enough material had been removed from the passing 1-1/2 inch portion, for the sodium sulphate soundness test, all oversize material retained on the 3/4-inch sieve including the portion retained on the 1-1/2 inch sieve was crushed to pass the 3/4-inch sieve and recombined with the natural material. Each sample then consisted of the following approximate percentages of crushed and natural material:

	908 Pit-run	909 Sink	910 Float
Natural	67%	38%	33%
Crushed	33%	62%	67%

Substantial amounts of screenings passing No. 4 sieve were produced and wasted in the crushing process and probably resulted in an improvement of the coarse aggregate.

Shrinkage bars 3" x 3" x 10" were then fabricated from the combined material using Perkins sand for fine aggregate and Calaveras cement, 6 sacks per cubic yard. The aggregate proportions by absolute volume were as follows:

Passing	3/4",	Retained	3/8"	35%
"	3/8",	"	No. 4	15%
"	No. 4			50%

Sufficient water was added to produce a slump of 3 to 3-1/2 inches. Water-cement ratios are shown in Table II. Two batches using each sample, 2 bars to a batch, were mixed on separate days on the "pit-run" and the "sink" material. There was insufficient float material for two batches consequently only 2 shrinkage bars could be made. The bars were stripped from the molds the day after they were made and then soaked in water at approximately 70°F for 6 days, then the initial length measurement was made. They were then placed in an oven at 100°F and a relative humidity of 70% for 7 days after which another length measurement was made representing the 7-day drying shrinkage. The bars were then soaked for another 7 days in water at approximately 70°F and were then broken in flexure after which the two ends from each bar were tested in compression as modified cubes. The results of these tests are shown in Table IV.

In an attempt to compare properties of this material with similar tests made in 1955 on other aggregates, the values for compressive strength, flexural strength, water-cement ratio, percent shrinkage and sedimentation values are shown plotted on their corresponding graphs with curves from the 1955 study drawn in. The level of shrinkage values in

the present tests in considerably lower than that of the 1955 series presumably because of differences in the shrinkage characteristics of the test cements.

The following notes made during the mixing and fabrication of the shrinkage bars are of interest:

908	Pit-run. As mixing continued, yellow clay particles broke up requiring the use of more water (to produce the required slump).
908	Pit-run, rewashed. The above condition not noticed with the washed sample. There was severe break-up in the pot wash, probably the above mentioned material.
909	Sink. Nothing unusual noticed during the mixing process.
910	Float. Only one batch was made of this material due to size of sample received. Did not notice the breakdown noted while mixing 908. Nothing unusual noticed during the mixing process.

DISCUSSION

The sample that was designated as "pit-run" contained only 2 percent passing No. 4 and this suggests that it had been screened to remove sand. The portion of the sample that was coarser than 3/4-inch met our requirements for sedimentation value but the 3/4 x No. 4 fraction did not. In fact there is doubt that this fraction could be made to pass the sedimentation test by a practical amount of plant washing because only a slight improvement was obtained when the sample was subjected to the rather thorough scrubbing of the first sedimentation test.

The sink material obtained by the heavy media separation showed lower absorption and marked improvement in sedimentation value and sodium sulphate soundness. The sink material was well within our requirements for sedimentation value and soundness.

Test specimens made of concrete containing 3/4-inch maximum size aggregate show that the heavy media separation reduced the drying shrinkage and increased the flexural and compressive strength significantly. The differences, however, are not as clear cut as desirable because of the unknown effect of crushing the samples preparatory to combining them into concrete. It was necessary to crush

the samples to 3/4-inch in order to obtain sufficient material for the tests. It is probable that the softer pieces of lower quality produced a disproportionate amount of screenings passing No. 4 and resulted in greater improvement of the pit-run coarse aggregate as compared with the sink material. On the other hand, the sample of pit run material made up for the concrete tests contained only 33 percent crushed material whereas the sink material was 62 percent crushed.

Rewashing of the pit-run material reduced drying shrinkage and increased strength to a greater degree than would be anticipated from the sedimentation test results. The sedimentation values shown in Table IV are the results of tests on the original samples. This test was not made on the samples after they were prepared for the concrete tests by crushing. It is certain that sedimentation values of the blended crushed and natural materials would have been lower because they contained portions of the 1-1/2 x 3/4-inch fraction which had much lower sedimentation values originally.

These uncertainties in test results were occasioned by the fact that the samples as submitted were not sufficiently large to make all of the tests desired.

Notwithstanding the uncertainties discussed above, the tests offer convincing evidence that the heavy media separation has resulted in a significant improvement in the test properties of the aggregate and of the resulting concrete.

TABLE I

Grading of Samples as Received

Lab. No.	56-908	56-909	56-910
Description	Pit-run	Sink	Float
% Passing 3"			81
2-1/2"			81
2"		100	75
1-1/2"	100	99	74
1"	58	52	64
3/4"	33	26	43
1/2"	20	17	
3/8"	8	9	13
No. 4	2	2	3
Wt. of Sample, lbs	200	100	20

TABLE II

Material	Nominal Size	Sp.Gr. SSD	Absorption Percent	Sedimentation Value	
				As Rec'd.	Rewash
56-908 Pit run	3/4 x #4	2.60	1.3	11.8	10.2
56-908 Pit run	1½ x 3/4	2.62	0.9	4.4	4.7
56-909 Sink	3/4 x #4	2.63	0.8	2.9	1.8
56-909 Sink	1½ x 3/4	2.65	0.5	2.3	2.4
56-910 Float	1 x #4	2.55	2.1	10.5	9.8

TABLE III

Sodium Sulphate Soundness Losses

Lab No. 56-908
Description - Pit Run

Size	% in sample	% loss	% of total
1½ x 1	42	6.1	2.56
1 x 3/4	25	9.5	2.38
3/4 x 1/2	13	18.2	2.37
1/2 x 3/8	12	25.4	3.05
3/8 x 4	8	26.0	2.08
		Weighted loss	12.4%

Lab No. 56-909
Description - Sink

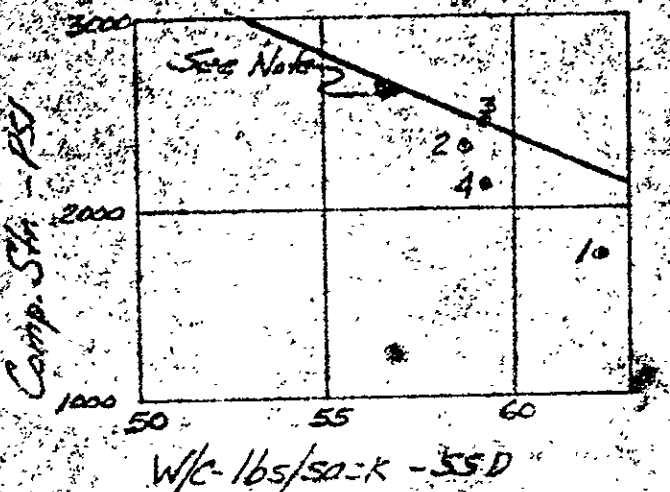
Size	% in sample	% loss	% of total
1½ x 1	48	1.1	0.53
1 x 3/4	26	3.7	0.96
3/4 x 1/2	9	1.4	0.13
1/2 x 3/8	8	3.0	0.24
3/8 x 4	9	2.0	0.18
		Weighted loss	2.0%

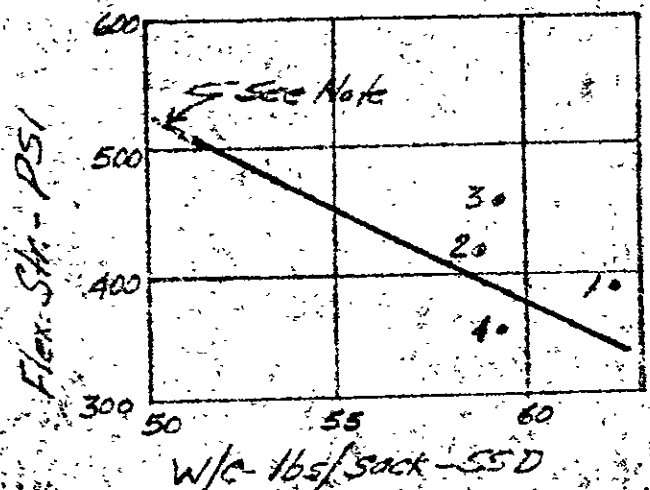
TABLE IV

Material 3/4 x #4	Condition As Used	S.V. Value	W/C lbs. per sack SSD	% Drying Shrinkage After 7 Days Average of 4	Strength, psi Flexural Avg. of 4	Strength, psi Compr Avg. of 8
56-908 Pit run	As Rec'd.	11.8	62.3	.026	380	1742
56-908 Pit run	Rewashed	10.2	58.7	.022	427	2316
56-909 Sink	As Rec'd.	2.9	59.2	.021	457	2458
56-910 Float	As Rec'd.	10.5	59.2	.028*	353*	2117*

*Shrinkage and flexural results are average of 2 on float material only.
Compressive results are average of 4 on float material only

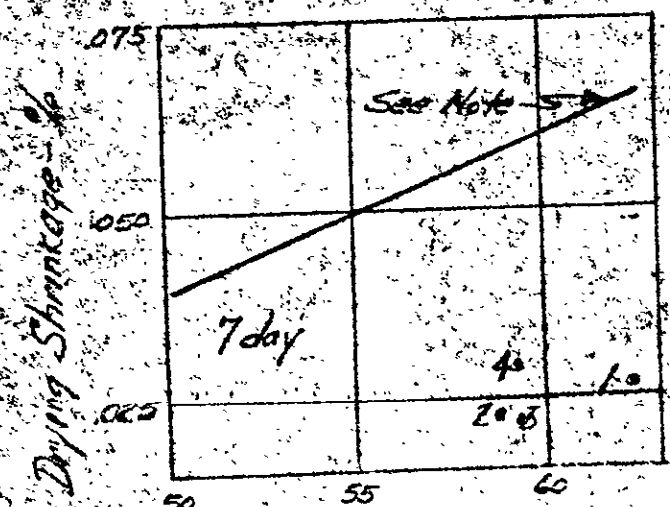
Relationship between Water-Cement Ratio and Comp. Strength, Flexural Strength and Drying Shrinkage



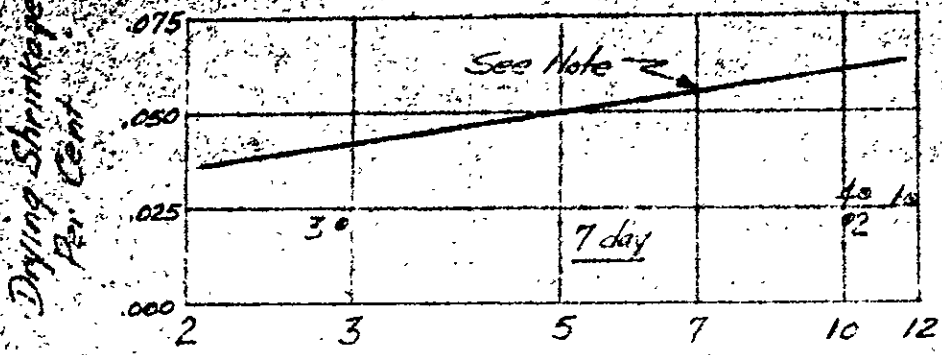


1- Pit Run - As Recd.
2- Pit Run - Re Washed
3 Sink Matl.
4 Float Matl.

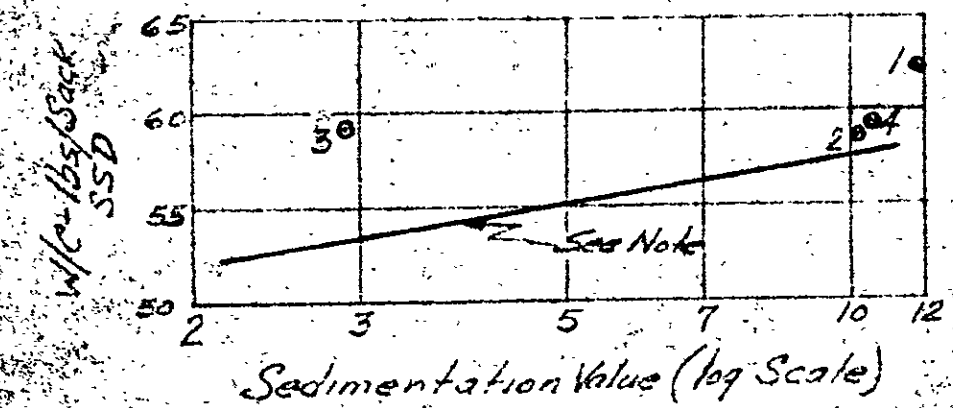
Note: Curves derived from Report of 9-1-55 on the Sedimentation Test



Relationship between Sedimentation Value and Drying Shrinkage and Water Cement Ratio

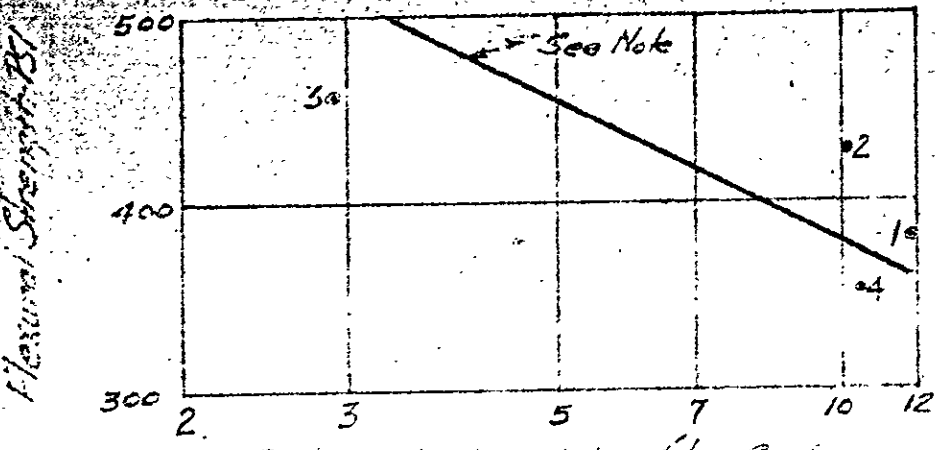


1. Pit Run - As Rec'd.
2. Pit Run - Re Washed
3. Sink Mat'l.
4. Float Mat'l.

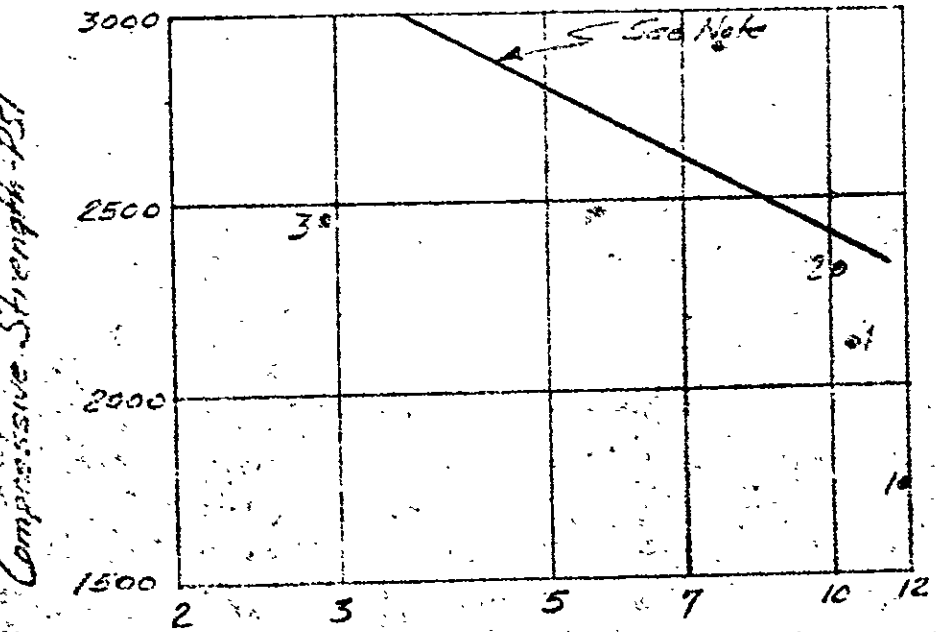


Note: Curves derived from Report of 9-1-55 on the Sedimentation Test.

Relationship between Sedimentation Value and Compressive Strength and Flexural Strength



1. Pit Run - As Recd
2. Pit Run - Re-Washed
3. Sink Mat'l
4. Float Mat'l



Note: Curves derived from Report of 9-1-55 on the Sedimentation Test